

08/28/00  
JC803 U.S. PTO

Patent  
Attorney's Docket No. 016660-055

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT  
APPLICATION TRANSMITTAL LETTER

JC875 U.S. PTO  
09/649084  
08/28/00

Box PATENT APPLICATION  
Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application of Wing Cheung HO, Siu Yan HO, Hon Shing LAW and Sui Wai CHUNG for WIRE-BONDING APPARATUS WITH IMPROVED XY-TABLE ORIENTATION.

Also enclosed are:

- ☒ 3 sheet(s) of ☒ formal ☐ informal drawing(s);
- ☐ a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 is ☐ hereby made to      filed in      on     ;  
☐ in the declaration;
- ☐ a certified copy of the priority document;
- ☐ a General Authorization for Petitions for Extensions of Time and Payment of Fees;
- ☐          statement(s) claiming small entity status;
- ☒ an Assignment document;
- ☐ an Information Disclosure Statement; and
- ☒ Other: Preliminary Amendment
- ☒ An ☒ executed ☐ unexecuted declaration of the inventor(s)  
☒ also is enclosed ☐ will follow.
- ☐ Please amend the specification by inserting before the first line the sentence --This application claims priority under 35 U.S.C. §§119 and/or 365 to      filed in      on     ; the entire content of which is hereby incorporated by reference.--
- ☐ A bibliographic data entry sheet is enclosed.



21839

☒ The filing fee has been calculated as follows ☒ and in accordance with the enclosed preliminary amendment:

CLAIMS					
	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee					\$690.00 (101)
Total Claims	11	MINUS 20 =	-0-	x \$18.00 (103)	-0-
Independent Claims	1	MINUS 3 =	-0-	x \$78.00 (102)	-0-
If multiple dependent claims are presented, add \$260.00 (104)					-0-
Total Application Fee					690.00
If verified Statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					-0-
Add Assignment Recording Fee if Assignment document is enclosed					40.00
<b>TOTAL APPLICATION FEE DUE</b>					<b>730.00</b>

☐ This application is being filed without a filing fee. Issuance of a Notice to File Missing Parts of Application is respectfully requested.

☒ A check in the amount of \$ 730.00 is enclosed for the fee due.

☐ Charge \$ \_\_\_\_\_ to Deposit Account No. 02-4800 for the fee due.

☒ The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.

Please address all correspondence concerning the present application to:

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Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: August 28, 2000

By: 

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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of	)	
	)	
Wing Cheung HO et al	)	Group Art Unit: Unassigned
	)	
Application No.: Unassigned	)	Examiner: Unassigned
	)	
Filed: August 28, 2000	)	
	)	
For: WIRE-BONDING APPARATUS	)	
WITH IMPROVED XY-TABLE	)	
ORIENTATION	)	

**PRELIMINARY AMENDMENT**

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination and the calculation of filing fees, kindly amend the above-identified application as follows.

**IN THE CLAIMS:**

Claim 3, line 1, delete "or 2".

Claim 4, line 1, delete "2 or 3".

Claim 5, line 1, delete "2 or 3".

Add the following new claims:

--7. Apparatus as claimed in claim 2 wherein said workpiece supporting means comprises a rotary table for rotating said workpiece.

8. Apparatus as claimed in claim 2, wherein said bonding head supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said workpiece along said X and Y axes.

9. Apparatus as claimed in claim 2 wherein said workpiece supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said bonding head supporting means along said X and Y axes.

10. Apparatus as claimed in claim 3, wherein said bonding head supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said workpiece along said X and Y axes.

11. Apparatus as claimed in claim 3 wherein said workpiece supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said bonding head supporting means along said X and Y axes.--

**IN THE ABSTRACT**


Numbered Line 10, change "shoter" to --shorter--.

**REMARKS**

Entry of the foregoing amendments is respectfully requested. These amendments are intended to eliminate the multiple dependency of the claims.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

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Date: August 28, 2000

WIRE-BONDING APPARATUS  
WITH IMPROVED XY-TABLE ORIENTATION

FIELD OF THE INVENTION

5        This invention relates to a wedge wire bonding apparatus, and in particular to such an apparatus having an improved xy-table orientation.

BACKGROUND OF THE INVENTION

Wire bonding apparatus for the bonding of semiconductor and other electronic  
10 components on to an integrated circuit board are generally divided into two types: ball bonding apparatus in which a ball, for example, of gold, is formed at the end of a wire to be bonded, and wedge wire bonding apparatus in which a wire is deformed as it is bonded.

Ball bonding apparatus require the bonding head to be movable in the three axes  
15 X, Y and Z. For wedge wire bonding apparatus, however, the workpiece or bonding head must also be orientable about its axis  $\theta$ . For example, if a wire is being bonded at two places, before the first bond is made, the workpiece is rotated so that the bonding head is aligned with a line joining the first and second bonds then, after the first bond has been made, the bonding head is moved towards the second bonding location. Of course it will  
20 be appreciated that it is relative movement of the bondhead and the workpiece that is necessary. One may be fixed and the other may move, or vice versa.

## PRIOR ART

Figs. 1 to 3 show in plan and perspective views three conventional configurations for such wire bonding apparatus. Referring firstly to Fig. 1, a workpiece 1 is mounted on rotatable table 2. Rotatable table 2 is in turn mounted on sliding tables 3, 4 that are adapted to move in mutually orthogonal X and Y axes. Located above the workpiece 1 is a bonding head 5 including a transducer 6 that extends along an axis. The bonding head 5 is adapted to move vertically along the Z axis by means of a sliding mechanism disposed on the side of a bonding head supporting member 7. In the prior art configuration of Fig. 1 it will be noted that the transducer 6 is supported such that it is parallel with the x axis.

10 In use, before a first bond had been made, the axis of the transducer 6 is aligned along the direction of a line between the first and the second bonds by rotating the workpiece using the rotating table. After the first bond is formed, the workpiece 1 is then moved along the X axis by sliding table 3 until the workpiece 1 is in the correct position for the bonding head 5 to carry out the second bond. The bonding head moving down in the Z direction forms the bond, and the bonding head moves up again in the Z direction after the bond has been formed.

15 In the prior art bonding apparatus of Fig. 1 it will be noted that the bonding head supporting member 7 is located in the space defined by the interior angle of the XY axes and that the transducer axis is parallel to the X axis of the moving table 3. The prior art configuration of Fig. 2 is similar to Fig. 1 except that in this configuration the transducer axis is parallel to the Y axis of moving table 4. In the prior art configuration of Fig. 2, after the workpiece has been rotated so that the positions of the first and second bonds



have been aligned with the transducer 6, the workpiece 1 is moved along the Y axis by means of sliding table 4.

Fig.3 shows an alternate prior art configuration in which the bonding head supporting member 7 is located outside of the interior angle defined the XY axes and the transducer 6 is orientated such that the transducer axis is perpendicular to a line bisecting the XY axes. In this prior art configuration, after the work piece has been rotated so that the transducer 6 is aligned with the first and second bond locations, the work piece is moved along both the X and Y axes to move the work piece into the correct position for the second bond to be formed.

It should be noted that in the prior conventional arrangements as shown in Figs.1 to 3, the position of the operator of the bonding apparatus is such that he looks at the bonding apparatus from a position by the side of the X axis and views the bonding operation along a direction perpendicular to the X axis. It is also important to note that in the prior art arrangement of Fig.3 an operator views the bonding process at an angle of 45° to the transducer axis which makes it difficult to properly observe the bonding process, and in particular makes it difficult to carry out necessary alignment and set-up steps.

#### SUMMARY OF THE INVENTION

It is an object of the invention to provide improved configurations for wedge wire bonding apparatus that provide more efficient operation.

According to the present invention therefore there is provided wedge wire bonding apparatus comprising:

- (a) means for supporting a workpiece,
- (b) a bonding head including a transducer having a longitudinal axis,
- (c) means for causing relative movement of the workpiece and the transducer along orthogonal X and Y axes simultaneously, and
- 5 (d) means for supporting the bonding head above the workpiece such that the longitudinal axis of said transducer lies along a line dividing said X and Y axes.

An advantage of the present invention in its preferred forms is that by moving the transducer relative to the workpiece along both the X and Y axes simultaneously, rather than only one of the two axes, the time spent for the movement of the transducer is  
10 significantly reduced. The maximum reduction in the travelling time of either the transducer or the workpiece (depending on which actually moves) is when the line bisects the X and Y axes equally making an angle of  $45^\circ$  to the X and Y axes and the travelling distance is reduced by a factor of 0.707 compared with when the movement is along one axis only. This reduces the travelling time by nearly 30%. The relative XY motion of the  
15 transducer and the workpiece is not of course the only time consuming part of the bonding operation, nonetheless it is a major one (30-50% of the cycle) and the total bonding cycle time can be reduced by around 9 to 15%.

In one embodiment of the invention the workpiece supporting means comprises a rotary table for rotating the workpiece.

20 In one embodiment, the bonding head is fixed and the workpiece supporting table moves in the X and Y axes. Alternatively, the workpiece supporting table is fixed in the X and Y axes and the bonding head moves in the X and Y axes.

It is also possible to optimise the position of an operator viewing the bonding process. In particular in a preferred embodiment of the invention that apparatus includes a position for an operator to observe the bonding procedure, and wherein the transducer is positioned so as to point in the direction of the operator position. This is an optimum position in that it allows the operator to observe fully the bonding process and greatly facilitates any required alignment and set-up operations that are necessary at the commencement of or during a bonding process.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the invention will now be described by way of example and with respect to the accompanying drawings, in which:-

Figs.1 to 3 are plan views from above of the configuration of the three examples of the prior art,

Fig.4 is a perspective view and a plan view from above of a first configuration in accordance with an embodiment of the invention,

Fig.5 is a perspective view of a wire bonding apparatus embodying the configuration of Fig.4, and

Fig.6 is a perspective view and a plan view from above of a second configuration in accordance with a further embodiment of the invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring firstly to Fig.4, it will be seen that in this first embodiment of the invention it will be seen that the bonding head supporting member 7 is located such that

when viewed in plan the transducer 6 is located within the interior angle of the X and Y axes and such that the longitudinal axis of the transducer 6 is located on a line that bisects the X and Y axes and forms an angle of  $45^\circ$  to each of them (or is located on a line closely adjacent and parallel to such a line). In this embodiment, before the first bond has  
5 been formed, the transducer axis is aligned with the first and second bond locations by rotating of the workpiece, and then after forming the first bond the work piece is moved simultaneously along both X and Y axes until the bonding head 5 is located above the second bond point and the second bond can be formed.

By arranging the transducer axis to be at  $45^\circ$  to both the X and Y axis and by  
10 moving the bonding head 5 along both axes simultaneously rather than just one of the two axes, the travelling distance in the X and Y axes of the bonding head can be reduced by a factor of 0.707 (i.e.  $\sin 45^\circ$ ) compared with a prior art configuration in which the transducer is positioned parallel to one of the two axes. Furthermore by locating operator in a position so as to view the bonding operation along the transducer axis as shown by  
15 the arrow in Fig.5, whereby the operator looks along the transducer axis, an optimum position is provided for an operator to be able to observe the bonding process, and to carry out any necessary alignment or set-up procedures either before commencement of or during the bonding process.

In the embodiment of Figs. 4 and 5, rotation of the workpiece relative to the  
20 transducer is accomplished by rotating the workpiece itself while keeping the transducer 6 fixed, and then this is followed by moving the workpiece along the X and Y axes again keeping the transducer 6 fixed. In the embodiment of Fig.6, the workpiece is again supported on a rotary supporting table to provide the desired movement about the  $\theta$  axis.

In this embodiment it is the transducer 6 that moves relative to the workpiece along the X and Y axes. This is achieved by fixing the bonding head supporting member 7 on one of the sliding tables 4 such that the orientation of the bonding head 5 relative to the X and Y axes is always fixed with the transducer axis being on a line that bisects the X and Y axes at 45° to each, though in this embodiment the transducer is directed so as to point towards the operator and away from the X and Y tables. The workpiece 1 is supported on a rotary table 10 fixed in the X and Y axes.

In the embodiment of Fig.6, before a first bond has been made the first and second bond locations are aligned with the axis of the transducer 6 by rotation of the workpiece supporting table 10 relative to the bonding head 5. When this alignment has been accomplished, the first bond is formed and then the bonding head 5 is moved to the second bonding position by movement along both the X and Y axes by sliding tables 3 and 4.

It will be understood that optimum results are obtained if the transducer axis bisects the X and Y axes at 45° to each axis. But an improvement can still be obtained if the transducer axis is located on a line that divides the X and Y axes other than by an equal bisection.

CLAIMS

1. Wedge wire bonding apparatus comprising:
- (a) means for supporting a workpiece,
  - (b) a bonding head including a transducer having a longitudinal axis,
  - 5 (c) means for causing relative movement of the workpiece and the transducer along orthogonal X and Y axes simultaneously, and
  - (d) means for supporting the bonding head above the workpiece such that the longitudinal axis of said transducer lies along a line dividing said X and Y axes.
- 10 2. Apparatus as claimed in claim 1 wherein the line dividing the X and Y axes makes an angle of 45° to the X and Y axes.
3. Apparatus as claimed in claim 1 or 2 wherein said workpiece supporting means comprises a rotary table for rotating said workpiece.
- 15 4. Apparatus as claimed in claim 1, 2 or 3 wherein said bonding head supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said workpiece along said X and Y axes.
- 20 5. Apparatus as claimed in claim 1, 2 or 3 wherein said workpiece supporting means is fixed relative to said X and Y axes and wherein means are provided for moving said bonding head supporting means along said X and Y axes.

- [illegible]

## ABSTRACT

## "WIRE-BONDING APPARATUS

5

WITH IMPROVED XY-TABLE ORIENTATION"

10

Wedge wire bonding apparatus are disclosed with an improved configuration in which the transducer axis lies on a line that bisects the XY axes, and the operator views the bonding process by looking directly along the axis of the transducer. The result is a shorter bonding cycle time as time is saved as the bonding head moves from a first to a second bonding position while at the same time the operator is placed in the best possible position for viewing the bonding operation, which facilitates in particular any necessary alignment and set-up steps.





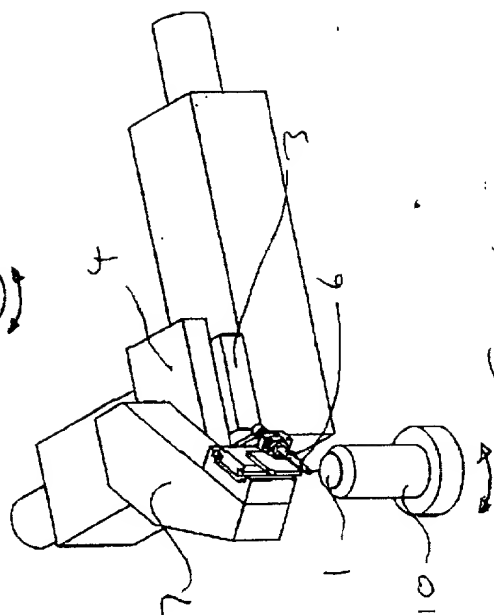
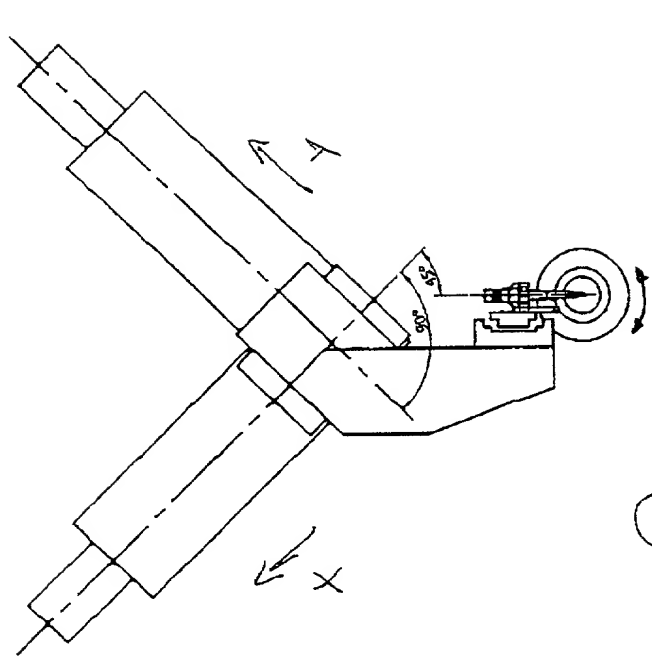


FIG. 6

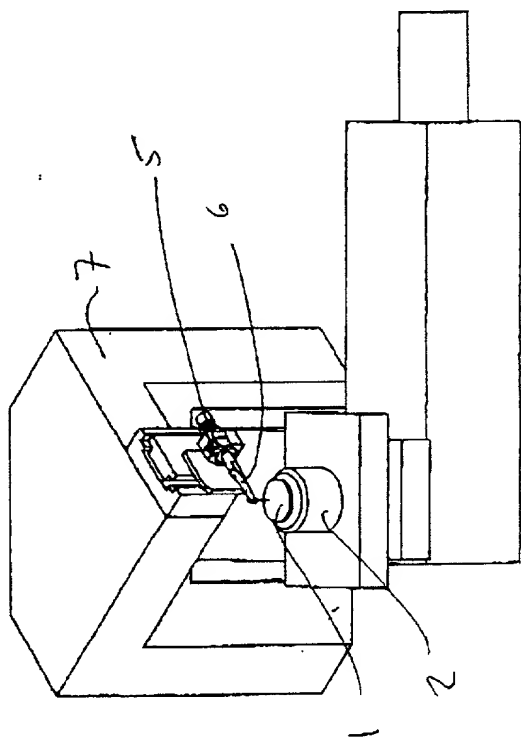
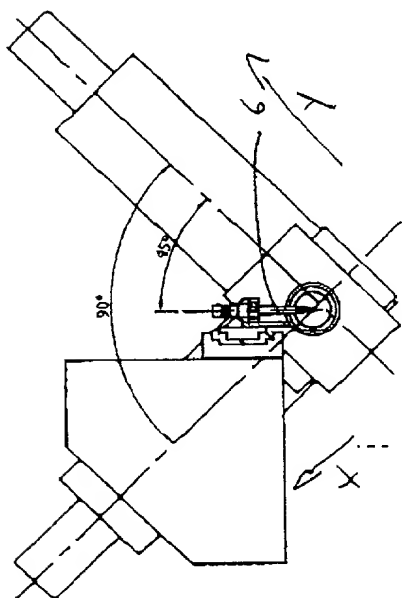


FIG. 4

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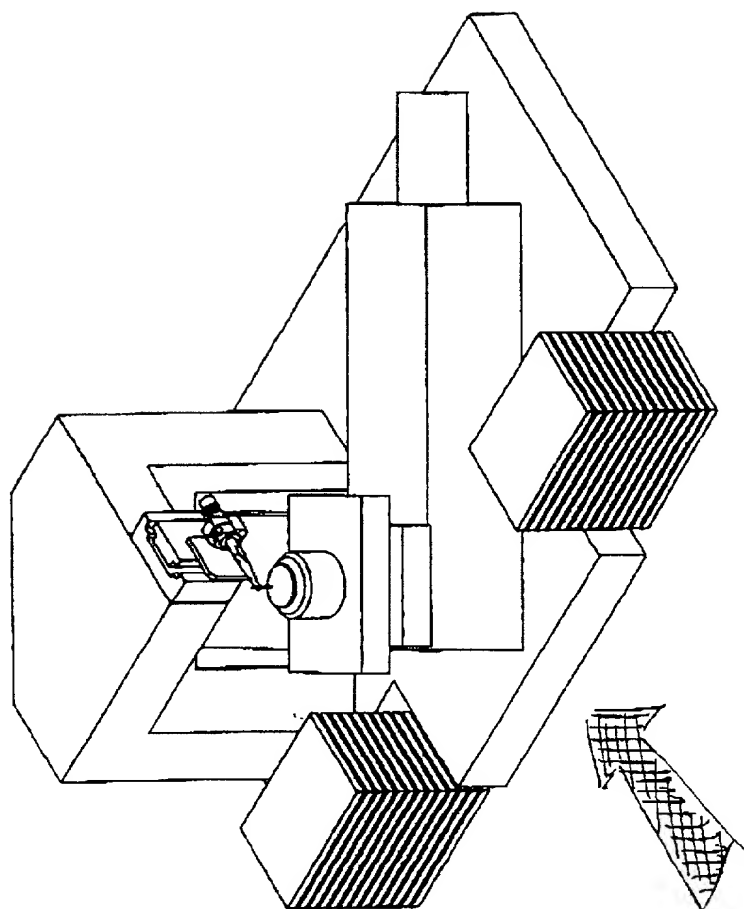


Fig. 5

COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR UTILITY PATENT APPLICATION

Attorney's Docket No.

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION ENTITLED:

"WIRE-BONDING APPARATUS WITH IMPROVED XY-TABLE ORIENTATION"

the specification of which

(check one)

☒ is attached hereto;

☐ was filed on \_\_\_\_\_ 25

Application No. \_\_\_\_\_

and was amended on \_\_\_\_\_;  
(if applicable)

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE:

I ACKNOWLEDGE THE DUTY TO DISCLOSE TO THE OFFICE ALL INFORMATION KNOWN TO ME TO BE MATERIAL TO PATENTABILITY AS DEFINED IN TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56 (as amended effective March 16, 1992);

I do not know and do not believe the said invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in the United States of America more than one year prior to said application; that said invention has not been patented or made the subject of an inventor's certificate issued before the date of said application in any country foreign to the United States of America on any application filed by me or my legal representatives or assigns more than twelve months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY			Attorney's Docket No.
COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES_ NO_
			YES_ NO_

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:


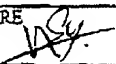
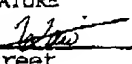
William L. Mathis	17,357	Robert G. Mukai	28,551	Bruce J. Boggs, Jr.	32,344
Peter H. Smolka	15,913	George A. Hovanes, Jr.	28,223	William H. Benz	25,952
Robert S. Swecker	19,885	James A. LaBarre	28,632	Peter K. Skiff	31,917
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Benton S. Duffer, Jr.	22,030	R. Danny Hunnington	27,903	Matthew L. Schneider	32,814
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Regis E. Sluter	26,999	William C. Rowland	30,888	Todd R. Walters	34,040
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Ralph L. Friesland, Jr.	16,110	Patrick C. Kanne	32,858		

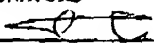
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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POST OFFICE ADDRESS		
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RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		
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RESIDENCE		CITIZENSHIP
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FULL NAME OF TENTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		
FULL NAME OF ELEVENTH JOINT INVENTOR, IF ANY	SIGNATURE	DATE
RESIDENCE		CITIZENSHIP
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